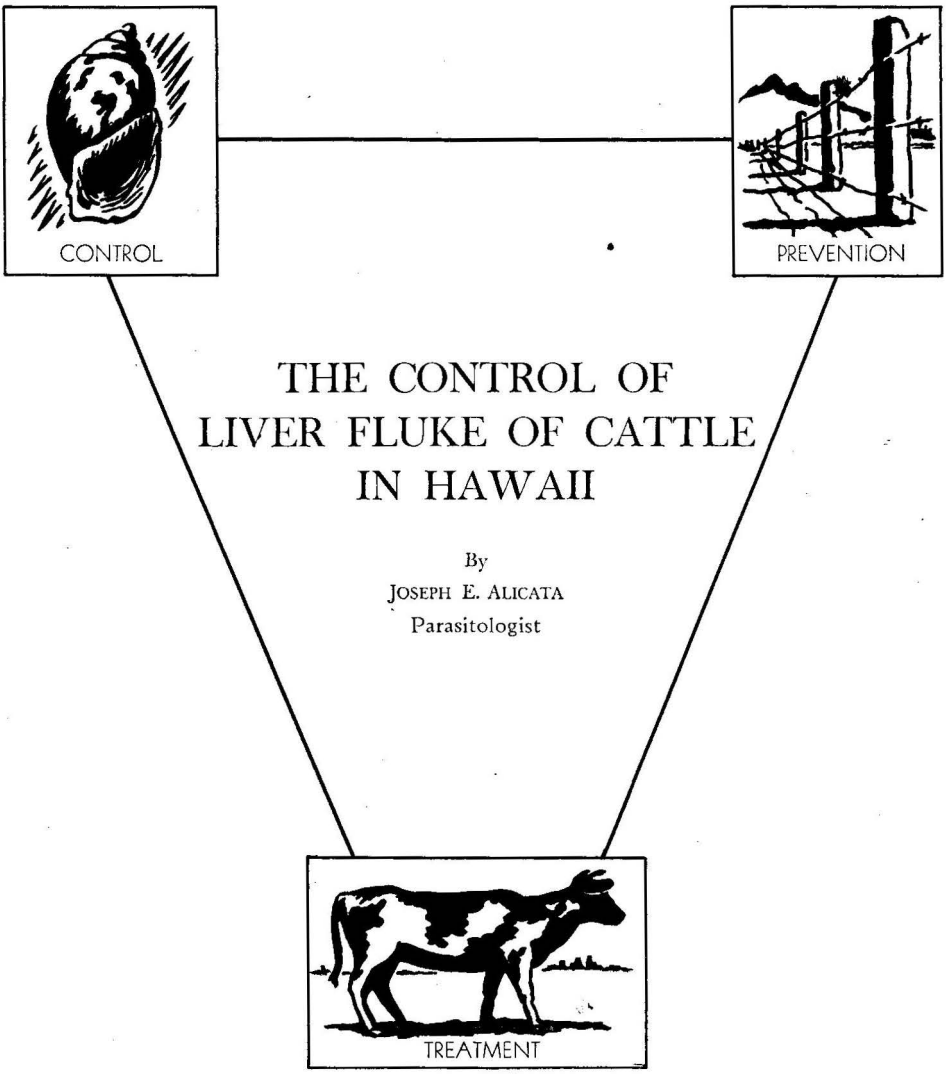


# THE CONTROL OF LIVER FLUKE OF CATTLE IN HAWAII

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This is a revision of Circular No. 15 which was issued by the Hawaii Agricultural Experiment Station in June 1940. It was titled Methods of Controlling the Liver Fluke of Cattle in Hawaii, and was by Joseph E. Alicata, Leonard E. Swanson (resigned), and G. W. H. Goo (resigned).

The present publication incorporates, among other things, newly recognized information on methods of treating cattle for liver flukes. The new methods are proving very valuable in the control of these economically important parasites.

## Contents

# The Control of Liver Fluke of Cattle in Hawaii

## INTRODUCTION

Liver fluke infection is the most important parasitic disease of beef and dairy cattle in the Hawaiian Islands. The parasite is widely distributed and is most commonly found among animals on the windward side of the islands where high rainfall is most common.

Fluke infection in cattle is dependent largely on an environment which makes it possible for the fresh-water snail, which serves as intermediate host, to live and propagate. Topography, rainfall, and temperature therefore play an important part. In the Hawaiian Islands there are relatively recent steep volcanic mountains varying from coastal to centric or eccentric in position. The contact of land with sea is made abruptly, or as a gradual transition over relatively flat land with very little drainage. These poorly drained lowlands and valleys with high rainfall, especially on the windward side, often present rather extensive swampy conditions. Although rainfall is most prevalent during the first or last months of the year, frequent showers throughout other months are sufficient to maintain swampiness. This constant presence of water coupled with mild temperature varying only about 5 to 8 degrees between the coldest and warmest months, make conditions suitable the year around for snail propagation and development and hatching of the fluke eggs. Moreover, local agricultural practices have for many years favored the spread of the flukes. With ample supply of vegetation, cattle have been allowed to graze continually, and some dairymen have also been in the habit of feeding cattle with forage cut from wet areas. These practices in the past have been largely responsible for the widespread occurrence of fluke infection in the Islands. In more recent years, however, with better understanding of the spread and prevention of the disease, and with utilization of specific drugs advanced through research by the parasitology departments of this and other stations, the fluke problem is now under better control than it was a few years ago.

Liver fluke infection of cattle in the Hawaiian Islands dates back at least to 1892 when A. Lutz (*8*) first reported its occurrence on Kauai, Oahu, Maui, and Molokai. At that time, examination of cattle slaughtered in Honolulu revealed 298 calves out of 620 (48 percent) and 1,313

cattle out of 2,186 (60 percent) infected with flukes. In 1905 Smith and Van Dine (*10*) reported that of 3,376 cattle slaughtered in Honolulu during a period of 6 months in 1902, 990 (29.3 percent) showed infection. In 1928 and 1931, Case (*6*) reported deaths of cattle caused by liver flukes and stated that the disease was widespread throughout the Territory, especially on Oahu and Kauai. According to a communication received from Dr. A. H. Julien, Federal Meat Inspector, of a group of 1,312 cattle largely from the windward side of Oahu slaughtered in Honolulu between July 1938 and March 1940, 1,149, or 87.5 percent, showed flukes or flukey lesions on the liver.

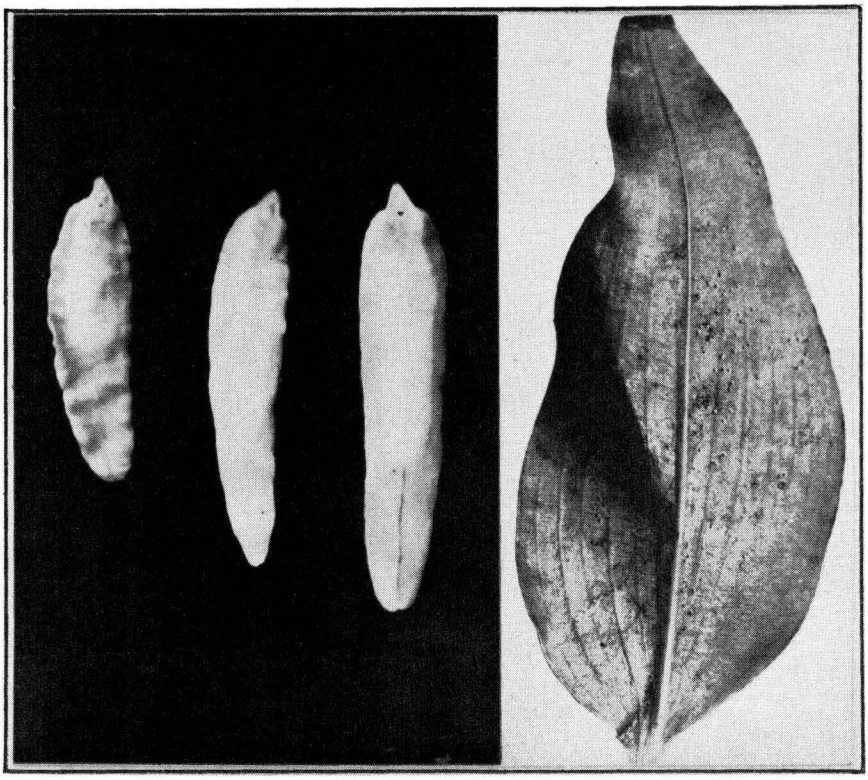
## NATURE OF THE LIVER-FLUKE PROBLEM AND LIFE HISTORY OF THE PARASITE

Control measures for any parasitic disease are predicated on an understanding of the life cycle of the parasite, its methods of perpetuation, and its resistance to various climatic and environmental conditions. Since reports on these factors in relation to the liver fluke in Hawaii have been published (*1, 5*), the pertinent points are summarized briefly here.

The liver fluke infecting cattle in Hawaii was at first believed to be *Fasciola hepatica,* a common parasite of sheep and cattle in the continental United States and many other parts of the world, but was later identified as a different species, *Fasciola gigantica* (*3*). There is a possibility, however, that *F. hepatica* may be found or may become established in the Islands. Cattle infected with the latter fluke are known to have been imported in this locality from the continental United States, and laboratory experiments have shown that the local fresh-water snails, *Fossaria ollula,* can serve as a suitable intermediate host. The liver fluke, *F. gigantica,* measures up to about 2 inches in length, ½ inch in width, and 1/32 inch in thickness (fig. 1, *a*). *F. hepatica* is a smaller fluke, measuring up to about 1¼ inches long and 1/3 to ½ inch wide.

The life cycle of the liver fluke, which is illustrated graphically in figure 2, is as follows:

The adult flukes, which live in the bile ducts of the liver of cattle, lay many eggs which are microscopic in size. These eggs eventually pass down with the bile to the small intestine and finally are voided with the manure. In the presence of water and at a suitable temperature, the eggs develop in about 14 days and hatch into small larvae known as miracidia. The miracidia swim in the water until they find a suitable snail which serves as intermediate host. If no snail is found, the miracidia die. In Hawaii the fresh-water snail, *Fossaria ollula,* commonly found in swamps and streams is the carrier of the flukes; other snails such as *Physa compacta,*



(a) (b)

*Figure 1.* (*a*) Adult liver flukes, *Fasciola gigantica* (about natural size); (*b*) liver-fluke cysts attached to a blade of honohono plant (enlarged about two times).

*Melania indefinita, M. mauiensis,* and *Vivipara chinensis* (fig. 3), which are present in similar areas, have not been found to serve as hosts. The miracidia bore into the body of a suitable snail, and, in a period of about 40 days, each gives rise to a brood of larvae known as cercariae. The cercariae escape from the snail and soon encyst on vegetation or other objects submerged to various depths in water. If a current exists in the water, the swimming cercariae are washed down and may, therefore, encyst some distance from the place where they emerged from the snails. Several hundred cercariae may emerge from a single snail; in actual count, 762 cercariae were eliminated from one snail during a period of 3 weeks. The encysted cercariae (fig. 1, *b*), commonly referred to as fluke cysts, are barely visible to the naked eye. They are round in shape and may vary in color from cream to dark brown. In heavily infested pastures, they are occasionally seen on vegetation—especially on leaves of honohono plants—

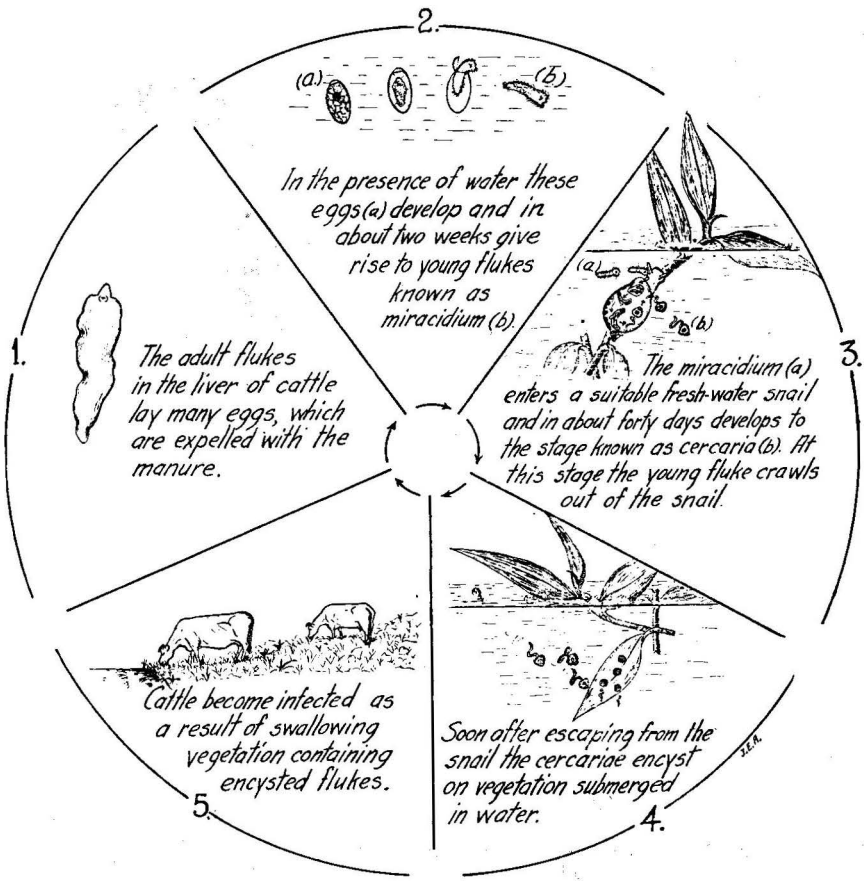



*Figure 2.* Life cycle of the liver fluke.

which has emerged slightly above the water level. In the presence of moisture, fluke cysts have been known to live for at least 4 months; there is a possibility that they remain alive longer. The cysts, however, are not able to withstand dryness or sunlight for long periods. Under experimental conditions, cysts attached to honohono plants growing outdoors in the sunlight under semi-dry conditions have been found dead after 42 days.

When live fluke cysts are swallowed by cattle or other susceptible mammals such as swine or human beings, the young flukes migrate to the liver and bile ducts. In these ducts the flukes reach sexual maturity in about 80 days, begin to lay eggs, and repeat the life cycle. Observation indicates that adult flukes may live in cattle at least 1 to 3 years and possibly longer (*4*).

The above information points out that there are three definite and im-

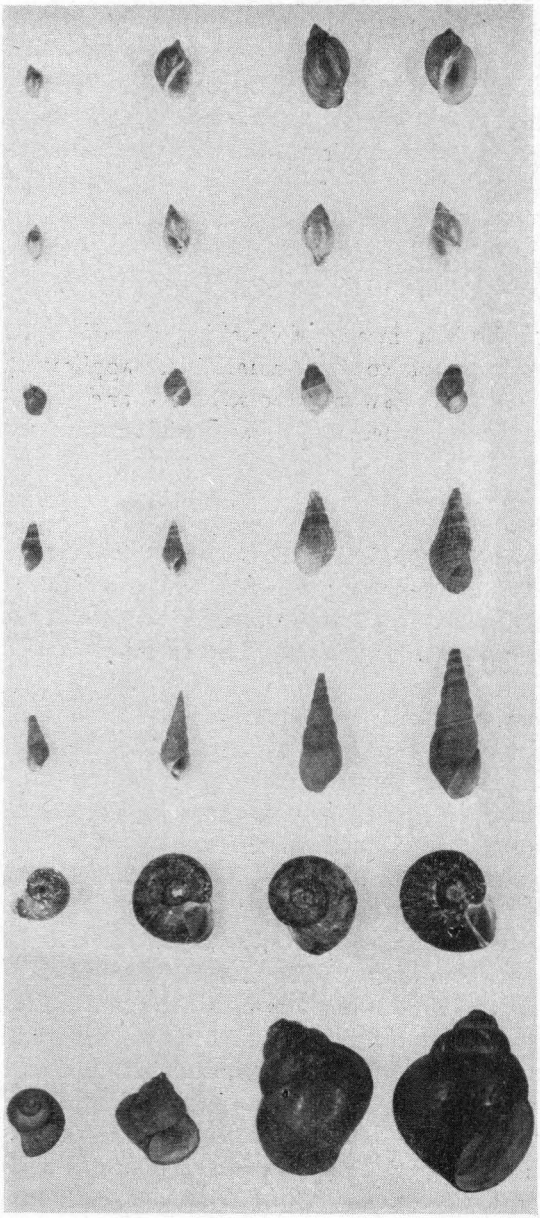



*Figure 3.* Common fresh-water snails (about natural size) found in local swamps and streams. Of these snails, only *Fossaria ollula* serves as intermediate host for liver flukes. (Note that the shell of *Fossaria ollula* opens on the right side whereas that of *Physa compacta* opens on the left side.)

portant phases in the life cycle of the parasite: (1) development in the snail, (2) encystment on vegetation, and (3) development in cattle. It follows, therefore, that control measures must be directed against (a) the snails, (b) the eating of infected vegetation by cattle, and (c) the flukes in the livers of cattle. Although the strict application of any control measures at any one stage would help to control the parasite, it is suggested that all three be practiced whenever possible.

## CONTROL OF THE SNAIL

Snail control offers one of the best means of breaking the life cycle of the fluke. Two of the most common control measures are application of copper sulfate to snail-infested areas (swamps or streams) and drainage of swamps and other areas where water accumulates and remains for long periods.

### *Copper Sulfate*

Of the various chemicals known to kill fresh-water snails, copper sulfate is the one commonly used since it is inexpensive and small quantities are very toxic to snails. Under local conditions, this method has been found to kill snails within about 48 hours. The chemical is also toxic to small fish.

When the chemical is to be applied over small pools of water, swampy areas, or drainage ditches, it may be broadcast by hand. To facilitate broadcasting, 1 part of the chemical is mixed with 4 parts of dry sand or other carrier. The method is estimated to require about 20 pounds of the chemical per acre. Copper sulfate is sold on the market in several forms, varying in size from powder to small rocks. The form preferred for broadcasting is the so-called "snow" size.

When copper sulfate is to be used in streams, a more or less definite concentration is essential. In glass containers, snails may be killed in dilutions of 1 part of copper sulfate to 1,000,000 parts of water; under field conditions higher concentrations are necessary as the presence of algae and decaying organic matter renders a great deal of the chemical inert. Under local field conditions, concentrations of 1 to 200,000 and 1 to 300,000 parts of water were found by Dr. L. E. Swanson, formerly of this Station, to be effective in destroying snails. A concentration of 1 to 500,000 was adequate only under certain conditions.

To estimate the amount of copper sulfate needed to treat the water in a given stream, it is necessary to know the flow of the water in cubic feet per second. This may be determined with a weir or by the use of float measurement as follows: Select a uniform portion of the stream and obtain its average width and depth. Obtain the velocity of the water by

ascertaining the number of seconds required for a small piece of wood to travel a given distance (a distance of 50 feet in 25 seconds shows a velocity of 2 feet per second). Multiply width, depth, velocity, and amount of copper sulfate at the desired concentration (for a 24-hour treatment at a dilution of 1 to 250,000, 22 pounds of copper sulfate are required for each cubic foot per second of flow). The following is given as an example.

A stream 6 feet wide and ½ foot deep, with a velocity of 2 feet per second, to be treated at the rate of 1 to 250,000, would require 132 pounds of copper sulfate per mile for a 24-hour treatment: *i.e.*,

| 6 | × | ½ | × | 2 | × | 22 | = | 132 pounds |
|---|---|---|---|---|---|---|---|---|
| (*width*) | | (*depth*) | | (*velocity*) | | (*concentration of copper sulfate*) | | |

One method of applying copper sulfate is to place a heavy burlap sack containing crystals, pea-sized or preferably larger, at the head of the stream and allow the copper sulfate to be dissolved by the running water. This type of treatment is effective for a maximum of 1 mile and, therefore, applications will be necessary at varying intervals. In areas where coral sand is present, copper sulfate is very difficult to apply as the chemical unites with the sand forming a hard, solidified mass. In treating a stream, it may be desirable to place several live snails in small wire-screen cages at various points in the stream to determine whether or not they are killed. If not, a stronger concentration of the chemical must be used.

A single application of copper sulfate in streams, although effective in killing the snails, is not effective in killing the eggs of these snails. Under local conditions, snail eggs hatch within from 6 to 10 days and the young snails reach the egg-laying stage about 26 days later; a second application of copper sulfate is desirable, therefore, about 15 days after the first.

When copper sulfate is applied in streams, the snails crawling around the edges just outside the water are often not affected. It is, therefore, also desirable to broadcast the chemical by hand in powdered or snow form (mixed at the rate of 1 to 4 parts of a carrier) along the margins.

*Drainage*

The presence of surface water in pastures is essential for the development and maintenance of fresh-water snails as well as for the development of the fluke eggs. Where it is possible, therefore, drainage is one of the most permanent methods of snail and fluke control.

Drainage ditches should be of adequate size to carry off all standing water. Since open ditches make ideal breeding grounds for snails, it is essential to keep the banks free of weeds and other vegetation. If snails are found in the ditches they can be destroyed by application of copper sulfate in powdered or snow form mixed with sand. When practical and

economical, drainage ditches should be tiled. Small areas of land which cannot be easily drained may be filled in and thus the source of danger will be permanently removed.

If an area is completely drained and the ground is comparatively dry, the adult snails are killed in about a week. However, the snails remain alive longer if the ground remains damp. Fluke cysts on vegetation are not readily affected by drainage. Under experimental outdoor conditions, cysts attached to honohono plants kept in sunny areas have been found infective after 15 days but not after 42 days. Cysts attached to plants and submerged under water have been found infective after 4 months but not after 8 months. These findings suggest that in order to prevent infection, animals should not be allowed to graze on drained land for at least several months following drainage.

## PREVENTION OF INFECTION IN CATTLE

One of the common methods of preventing infection in cattle is to fence off infested pasture areas; another is to feed vegetation which has been cut in dry areas known to be free from infestation.

Fencing is not ordinarily regarded as an economically practical method of fluke control as it takes land which otherwise might be utilized for pasturage or crops out of production. Moreover, it does not effectively control flukes if cattle are maintained where feces containing fluke eggs may be washed into the fenced area. Water flowing from the fenced areas may contain fluke cercariae which will encyst on vegetation in unfenced areas; fluke cysts which may become detached from infected vegetation may also travel to unfenced areas and serve to infect cattle drinking from these areas. In addition, if the fence does not follow the outlets of the swamp or slough throughout the pasture, cattle may become infected by consuming grasses along these outlets. Where drainage is economically impractical, however, fences built in such a manner that cattle cannot reach or break through to obtain grass should be installed about 10 feet from all boggy or wet areas.

## TREATMENT OF CATTLE FOR LIVER FLUKES

### *Purpose and Limitations*

The purpose of treatment is to destroy the flukes in the liver. This results in improving the physical condition (fig. 4) and productivity of the animal. It also reduces pasture contamination, a feature very important in fluke control.

Liver flukes, as do many other parasites, produce at least two major harmful host effects. They feed on and destroy the tissues which they

invade, and produce toxins or poisonous secretions which are harmful. Primarily, parasites cause chronic emaciation and unthriftiness; but even when present in large numbers they rarely kill the host. Beef cattle which are infected rarely attain top-grade market quality, and reports indicate that milk secretion in heavily infected dairy cows may be reduced as much as 16 percent. The maintenance of a fluke-infected herd, therefore, is a definite liability to the owner, resulting in uneconomic use of feed, pasture, time, and effort.

There is no drug known at the present time which is always 100 percent effective in destroying liver flukes. Immature flukes which are on their way to the liver, or already in the liver, are frequently not affected by medication. In addition, treatment does not prevent reinfection, and therefore, if this method alone is used, it has only a limited influence on fluke control. Treated animals should, as much as possible, be kept from reinfection by methods already outlined.

*Desirable Period for Treatment*

Owing to uniform climatic condition in Hawaii, fluke infection is likely to occur at any time of the year. The desirable period of treatment should therefore be determined by condition of the animal or by pasture-management practices. Beef cattle may be treated at any time except within 30 days before calving or while in full lactation. It is desirable, also, to treat beef cattle before they are moved from an infested to a clean area. Dairy cows may be treated most economically near the end of calving time. Drug treatment usually causes a temporary drop in milk secretion and the milk acquires a bitter taste for a few days. Although such milk may be suitable for animal consumption, it should not be used by human beings.

How frequently animals can be treated without harmful effects is not known. However, it appears desirable and safe to treat beef cattle exposed to infection at least twice a year on a herd basis, and dairy cattle at least once a year when not in lactation. Since the development of the fluke in cattle is completed in about 3 months, one or two treatments a year do not effectively control the parasite but offer a means of protecting and improving the health of the animal and reducing pasture contamination.

*Drug Suitable for Treatment*

Hexachloroethane is the drug of choice for the treatment of cattle against liver fluke. It is effective in destroying all or most of the adult flukes in the liver of the animal. Although this drug was first used in Europe in 1926 (*11*), it did not receive recognition in the United States until after extensive studies were reported in 1941 (*2*) by the Hawaii Agricultural Experiment Station.

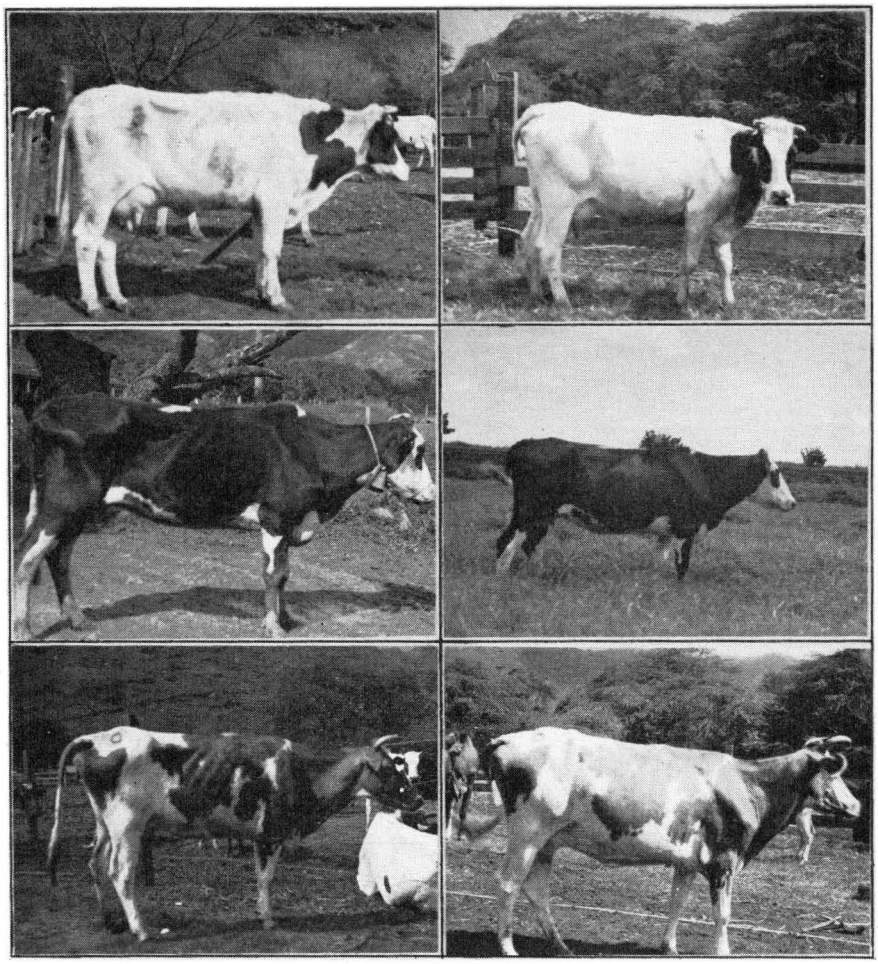


*Figure 4.* Three fluke-infected cows treated with hexachloroethane. *Left,* physical appearance before treatment. *Right,* about 4 months after treatment.

Hexachloroethane may be administered to cattle (a) in dry form mixed with kamala extract placed in gelatine capsules or (b) in an emulsion form mixed with bentonite and water. The use of the dry form was suggested by this Station in 1941 (*2*) and consisted in the preparation of large (No. 10) gelatine capsules each containing 10 grams of finely ground hexachloroethane (60-mesh size) mixed with 1.75 grams of kamala extract. The use of the emulsion form was suggested by Olsen (*9*) in 1943 and is prepared in the following proportions: finely ground hexachloroethane, 500 grams; powdered bentonite, 50 grams; tap water, 750 cc.; and white flour, ¼ teaspoonful. The above ingredients are mixed to-

gether with an electric mixer. A 20-cc. portion of the emulsion contains 10 grams hexachloroethane.

*Method of Treatment with Hexachloroethane*

Satisfactory results have been obtained by this Station when the drug is administered in one dosage to young animals (about 300 to 500 pounds) at the rate of 20 cc. hexachloroethane-bentonite-water emulsion, or 1 capsule of hexachloroethane-kamala extract to each 100 pounds live weight. Olsen (*9*) has reported the use of 20 cc. of the emulsion to each 100 pounds live weight, presumably for animals of all sizes. The emulsion is administered to cattle with the aid of a drench syringe or bottle, and the capsules with a capsule gun (fig. 5).

In the treatment of grown or large animals, this Station has found that the 1-day treatment frequently reduces the number of flukes in the liver, but does not completely eliminate the parasite as frequently as the use of a 2-day treatment. By the latter method, the amount of drug is increased and is administered at the rate of 20 cc. of the emulsion, or of 1 capsule, to each 70 pounds live weight; the calculated amount is given one-half the first day and the other half the following day (see table 1).

*Table 1.* Method of estimating amount of hexachloroethane-bentonite-water emulsion, or number of capsules containing hexachloroethane-kamala extract, to administer to cattle for the treatment of liver-fluke infection. (See Appendix tables A and B for estimating weight of cattle.)

| One-day treatment[1] | | | Two-day treatment[2] | | |
|---|---|---|---|---|---|
| Live weight of animal | Emulsion[3] | Capsules | Live weight of animal | Emulsion[3] | Capsules |
| *Pounds* | *cc.* | *Number* | *Pounds* | *cc.* | *Number* |
| 100 to 150 | 20 | 1 | 500 to 525 | 70-70 | 4-3 |
| 151 " 250 | 40 | 2 | 526 " 595 | 80-80 | 4-4 |
| 251 " 350 | 60 | 3 | 596 " 665 | 90-90 | 5-4 |
| 351 " 450 | 80 | 4 | 666 " 735 | 100-100 | 5-5 |
| 451 " 500 | 100 | 5 | 736 " 805 | 110-110 | 6-5 |
| 501 " 650 | 120 | 6 | 806 " 875 | 120-120 | 6-6 |
| 651 " 750 | 140 | 7 | 876 " 945 | 130-130 | 7-6 |
| 751 " 850 | 160 | 8 | 946 and up | 140-140 | 7-7 |
| 851 " 950 | 180 | 9 | | | |
| 951 and up | 200 | 10 | | | |

[1]Suggested for animals weighing less than 500 pounds or for larger animals for which it is not economically feasible to use the 2-day treatment.
[2]Suggested for animals weighing more than 500 pounds.
[3]About 30 cc. equals 1 ounce.

Since hexachloroethane has a wide margin of safety, it may be possible under ordinary practice to administer to young animals weighing

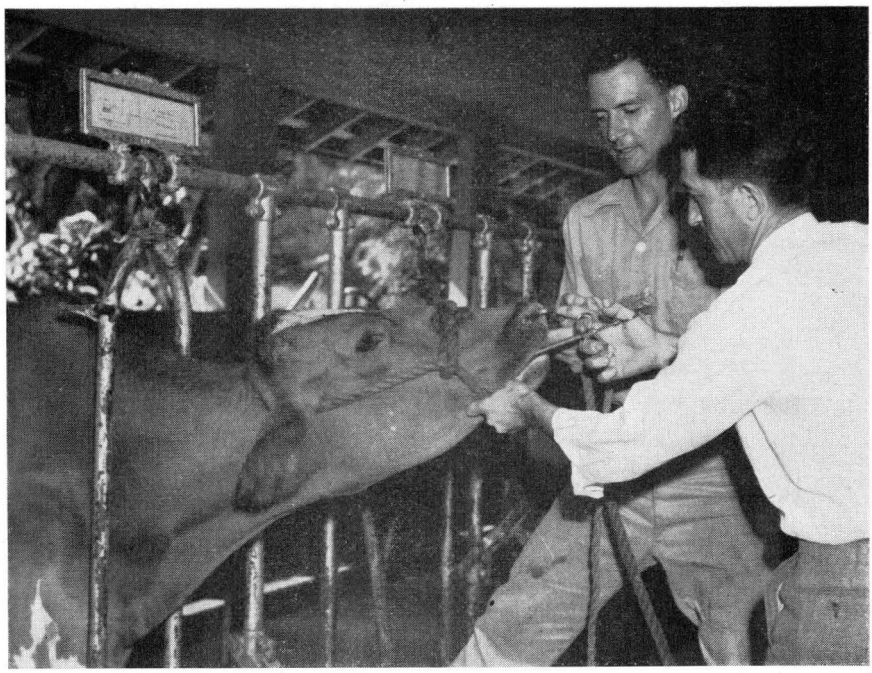


*Figure 5.* Hexachloroethane may be administered to cattle with the aid of a capsule-gun or dose-syringe as shown above.

around 350 to 500 pounds, 100 cc. (3 1/3 ounces) of emulsion, or 5 capsules, in one treatment. Animals weighing around 800 to 1,000 pounds may receive 200 cc. (6 2/3 ounces) of emulsion, or 10 capsules, in one treatment. If a 2-day treatment is used, it will require a total of 260 cc. of emulsion, or 13 capsules, this given one-half the first day and the other half the following day.

Hexachloroethane, when used as outlined above, is well tolerated by most cattle. Animals which are extremely debilitated may show staggering and prostration. Dairy cattle may occasionally show lack of appetite for a day or two following treatment. On account of the unfavorable effects which are at times experienced, it is desirable to have cattle treated by, or under supervision of, a veterinarian who is best able to select the dosage in relation to the body tolerance of the animal.

The following points should be considered in treating cattle for liver flukes:

1. Especially in dealing with dairy cattle, which may be subnormal in blood calcium, supply an adequate amount of feed rich in calcium (such as steamed bone meal or cane molasses) for a few days

before treatment. The unfavorable results, such as staggering, occasionally noted in cattle, are believed by some investigators to be due to blood calcium deficiency.

2. Administer the drug early in the morning before feeding, and starve the animal at least 3 hours after treatment.

3. Feed a moderate diet on the day of treatment, avoiding excess of protein concentrates.

4. Milk from lactating cows under treatment should not be used for human consumption for a few days following treatment. Such milk, however, may be fed to animals. Some dairymen have reported diarrhea in calves fed milk from cattle treated 24 hours previously.

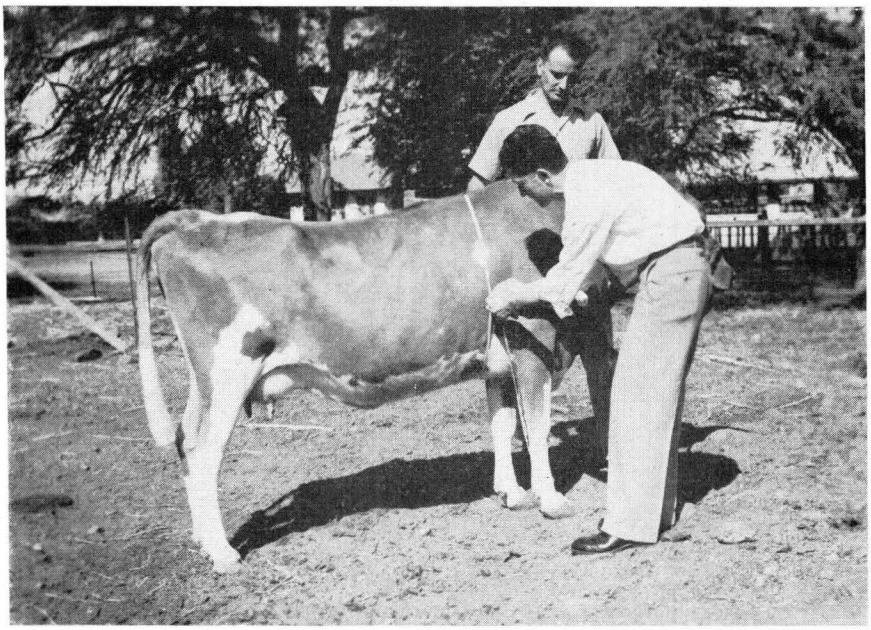


*Figure 6.* Method of estimating the weight of a cow by heart-girth measurement.

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## APPENDIX

The quantitative administration of hexachloroethane is based on body weight of infected animals. If it is not practical to weigh each animal before treatment, the weight may be estimated from measurements of heart girth (fig. 6), used in connection with a table prepared by the U. S. Department of Agriculture. Instructions for the procedure are given by Knapp,[1] as follows:

"To obtain a reasonably accurate measurement, the animal should be placed squarely on all four feet, with its head in the normal upright position. A steel or cloth tape, three-eighths or one-half inch wide, should be used to take the measurement. The tape should be placed around the animal at the point of smallest circumference just back of the fore legs. The tape should be pulled snugly about the animal, tight enough to make the hair lie down but not tight enough to indent the flesh. It is better to take several measurements and use the average as the true measurement . . ."

The tables for estimating weights of beef cattle of good grade and dairy cattle are given on the two pages following.

[1]KNAPP, BRADFORD, JR. A Method of Estimating the Weights of Beef and Dual-Purpose Cattle from Heart-Girth Measurements. U. S. Dept. Agr. Bur. Anim. Ind., A.H.D. No. 24, 4 pp., 1937.

*Table A.* Estimating the weights of beef cattle of good grade by heart-girth measurements[1]

| Heart girth | Weight | Heart girth | Weight | Heart girth | Weight |
|---|---|---|---|---|---|
| *Inches* | *Pounds* | *Inches* | *Pounds* | *Inches* | *Pounds* |
| 30 | 78 | 50 | 372 | 70 | 910 |
| 30½ | 82 | 50½ | 382 | 70½ | 926 |
| 31 | 87 | 51 | 393 | 71 | 942 |
| 31½ | 91 | 51½ | 404 | 71½ | 959 |
| 32 | 96 | 52 | 415 | 72 | 977 |
| 32½ | 101 | 52½ | 426 | 72½ | 994 |
| 33 | 106 | 53 | 437 | 73 | 1,011 |
| 33½ | 112 | 53½ | 449 | 73½ | 1,029 |
| 34 | 118 | 54 | 461 | 74 | 1,047 |
| 34½ | 123 | 54½ | 472 | 74½ | 1,065 |
| 35 | 129 | 55 | 484 | 75 | 1,083 |
| 35½ | 135 | 55½ | 496 | 75½ | 1,100 |
| 36 | 141 | 56 | 508 | 76 | 1,117 |
| 36½ | 147 | 56½ | 520 | 76½ | 1,135 |
| 37 | 153 | 57 | 533 | 77 | 1,154 |
| 37½ | 159 | 57½ | 545 | 77½ | 1,173 |
| 38 | 166 | 58 | 558 | 78 | 1,192 |
| 38½ | 173 | 58½ | 571 | 78½ | 1,211 |
| 39 | 181 | 59 | 585 | 79 | 1,230 |
| 39½ | 188 | 59½ | 598 | 79½ | 1,249 |
| 40 | 195 | 60 | 611 | 80 | 1,269 |
| 40½ | 202 | 60½ | 624 | 80½ | 1,288 |
| 41 | 210 | 61 | 637 | 81 | 1,308 |
| 41½ | 218 | 61½ | 651 | 81½ | 1,328 |
| 42 | 226 | 62 | 665 | 82 | 1,348 |
| 42½ | 234 | 62½ | 679 | 82½ | 1,368 |
| 43 | 242 | 63 | 693 | 83 | 1,388 |
| 43½ | 250 | 63½ | 708 | 83½ | 1,409 |
| 44 | 259 | 64 | 723 | 84 | 1,430 |
| 44½ | 267 | 64½ | 738 | 84½ | 1,451 |
| 45 | 276 | 65 | 753 | 85 | 1,472 |
| 45½ | 285 | 65½ | 768 | 85½ | 1,493 |
| 46 | 294 | 66 | 783 | 86 | 1,514 |
| 46½ | 303 | 66½ | 798 | 86½ | 1,535 |
| 47 | 313 | 67 | 814 | 87 | 1,557 |
| | | | | 87½ | 1,578 |
| 47½ | 322 | 67½ | 829 | | |
| 48 | 332 | 68 | 845 | 88 | 1,600 |
| 48½ | 342 | 68½ | 861 | 88½ | 1,622 |
| 49 | 352 | 69 | 877 | 89 | 1,644 |
| 49½ | 362 | 69½ | 893 | 89½ | 1,667 |

[1]Source: KNAPP, BRADFORD, JR. (Cited p. 17.)

*Table B.* Estimating the weights of dairy cows by heart-girth measurements[1]

| Heart girth | Weight | Heart girth | Weight | Heart girth | Weight | Heart girth | Weight |
|---|---|---|---|---|---|---|---|
| *Inches* | *Pounds* | *Inches* | *Pounds* | *Inches* | *Pounds* | *Inches* | *Pounds* |
| 26 | 80 | 43½ | 266 | 61 | 668 | 78½ | 1,354 |
| 26½ | 82 | 44 | 275 | 61½ | 684 | 79 | 1,377 |
| 27 | 84 | 44½ | 284 | 62 | 700 | 79½ | 1,400 |
| 27½ | 86 | 45 | 294 | 62½ | 716 | 80 | 1,423 |
| 28 | 89 | 45½ | 304 | 63 | 732 | 80½ | 1,446 |
| 28½ | 92 | 46 | 314 | 63½ | 749 | 81 | 1,469 |
| 29 | 95 | 46½ | 324 | 64 | 766 | 81½ | 1,492 |
| 29½ | 98 | 47 | 334 | 64½ | 783 | 82 | 1,515 |
| 30 | 101 | 47½ | 344 | 65 | 800 | 82½ | 1,538 |
| 30½ | 104 | 48 | 354 | 65½ | 817 | 83 | 1,561 |
| 31 | 108 | 48½ | 364 | 66 | 835 | 83½ | 1,584 |
| 31½ | 113 | 49 | 374 | 66½ | 853 | 84 | 1,607 |
| 32 | 118 | 49½ | 384 | 67 | 871 | 84½ | 1,630 |
| 32½ | 123 | 50 | 394 | 67½ | 889 | 85 | 1,653 |
| 33 | 128 | 50½ | 404 | 68 | 908 | 85½ | 1,676 |
| 33½ | 133 | 51 | 414 | 68½ | 927 | 86 | 1,699 |
| 34 | 138 | 51½ | 424 | 69 | 947 | 86½ | 1,722 |
| 34½ | 143 | 52 | 434 | 69½ | 967 | 87 | 1,745 |
| 35 | 148 | 52½ | 445 | 70 | 987 | 87½ | 1,768 |
| 35½ | 153 | 53 | 456 | 70½ | 1,007 | 88 | 1,791 |
| 36 | 158 | 53½ | 467 | 71 | 1,027 | 88½ | 1,814 |
| 36½ | 163 | 54 | 478 | 71½ | 1,048 | 89 | 1,837 |
| 37 | 168 | 54½ | 489 | 72 | 1,069 | 89½ | 1,860 |
| 37½ | 174 | 55 | 501 | 72½ | 1,090 | 90 | 1,883 |
| 38 | 180 | 55½ | 513 | 73 | 1,111 | 90½ | 1,906 |
| 38½ | 186 | 56 | 526 | 73½ | 1,132 | 91 | 1,929 |
| 39 | 192 | 56½ | 539 | 74 | 1,153 | 91½ | 1,952 |
| 39½ | 200 | 57 | 552 | 74½ | 1,175 | 92 | 1,975 |
| 40 | 208 | 57½ | 565 | 75 | 1,197 | | |
| 40½ | 216 | 58 | 579 | 75½ | 1,219 | | |
| 41 | 224 | 58½ | 593 | 76 | 1,241 | | |
| 41½ | 232 | 59 | 607 | 76½ | 1,263 | | |
| 42 | 240 | 59½ | 622 | 77 | 1,285 | | |
| 42½ | 248 | 60 | 637 | 77½ | 1,308 | | |
| 43 | 257 | 60½ | 652 | 78 | 1,331 | | |

[1]Source: KENDRICK, J. F., and PARKER, J. B. ESTIMATING THE WEIGHTS OF DAIRY COWS FROM HEART-GIRTH MEASUREMENTS. U. S. Dept. Agr. Bur. Dairy Ind. Mimeo. 695, 2 pp., 1936.

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